Beam Break Up Control for Dielectric Wakefield Accelerators

Euclid: P. Schoessow, A. Kanareykin, C. Jing, A. Kustov

ANL: W. Gai, J.G. Power, S. Antipov

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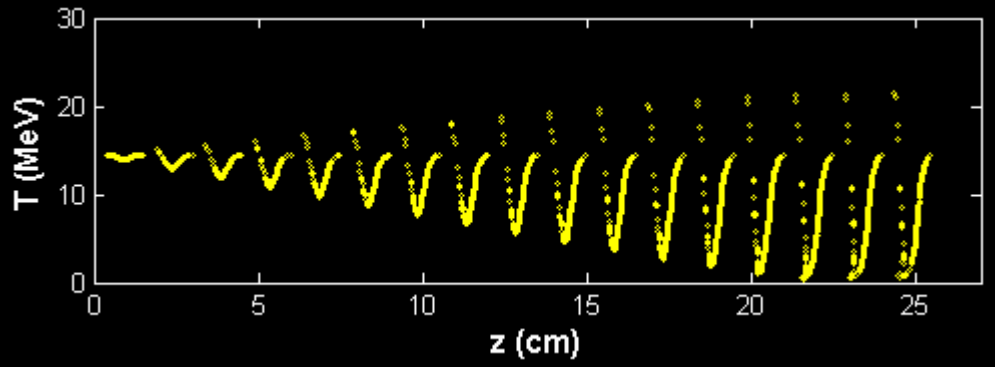
- The high current beam driving an efficient wakefield accelerator suffers a significant decrease in quality
  - physical emittance growth
  - increasing (and nonuniform) energy spread
  - deflection of trailing electrons by parasitic wakefields

Longitudinal phase space plot, high gradient structure. Data shown at 50 ps intervals.



- ☞leads to severe reduction in beam intensity
- use a quadrupole focusing channel around the wakefield structure to control single bunch beam breakup

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SBIR Project: Beam Breakup Instability in Dielectric Structures

- Experimental and computational aspects
- **BBU-3000** code development: particle-Green's function algorithm.

- AWA experiments. Three test cases planned:
  - 26 GHz power extractor;
  - ramped bunch train;
  - high gradient (small aperture) structure
- Study mitigation of BBU through the use of a FODO channel around the test device

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Planned Experiments

	a (mm)	*b (mm)*	*L (cm)*	ε	**Beam characteristics**
26 GHz Power Extractor	3.5	4.534	30	6.64	20 nC train, spacing = 23.1 cm
Ramped Bunch Train	3	3.667	40	16	5-15-25-35 nC train, spacing=23.1 cm
High Gradient	1.5	7.49	25.4	3.78	Single 100 nC bunch

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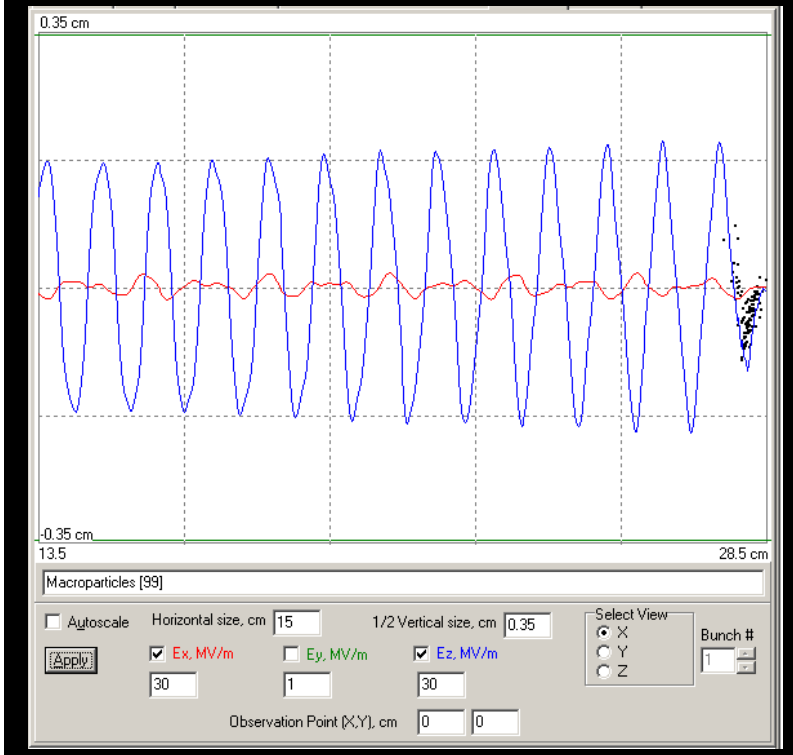
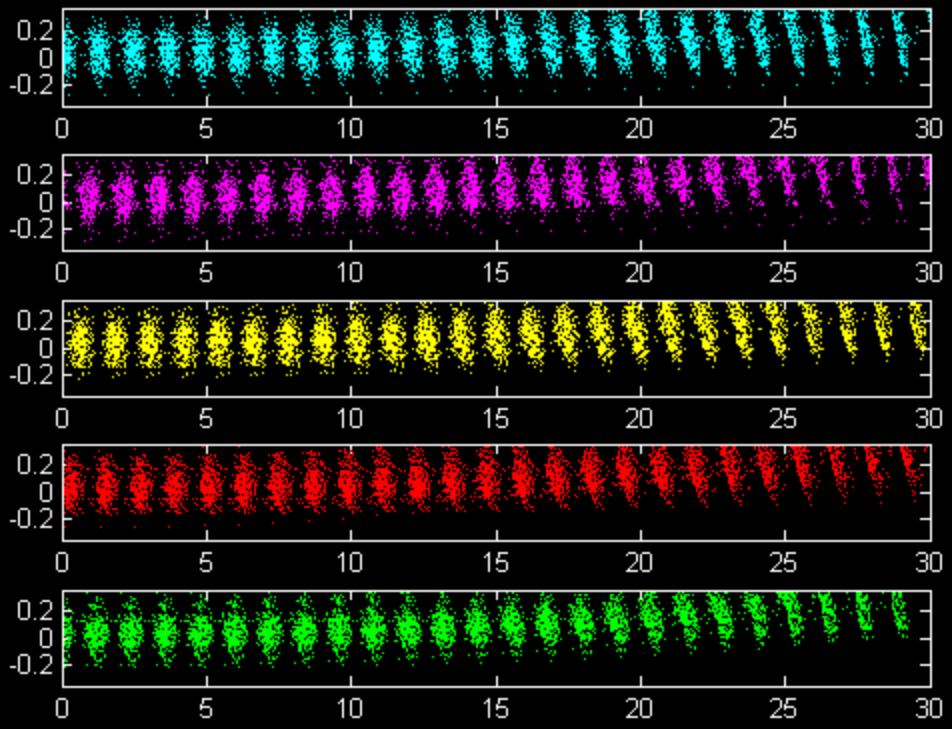
Power Extractor Simulations



BBU-3000 screen capture



26GHz decelerator, five bunch train computed using BBU-3000. Top to bottom, bunches 1-5 at 40ps intervals. Initial offset of 0.4mm in the positive x direction. Distances in cm; vertical extent of each plot corresponds to the width of the vacuum channel (±0.35 cm).

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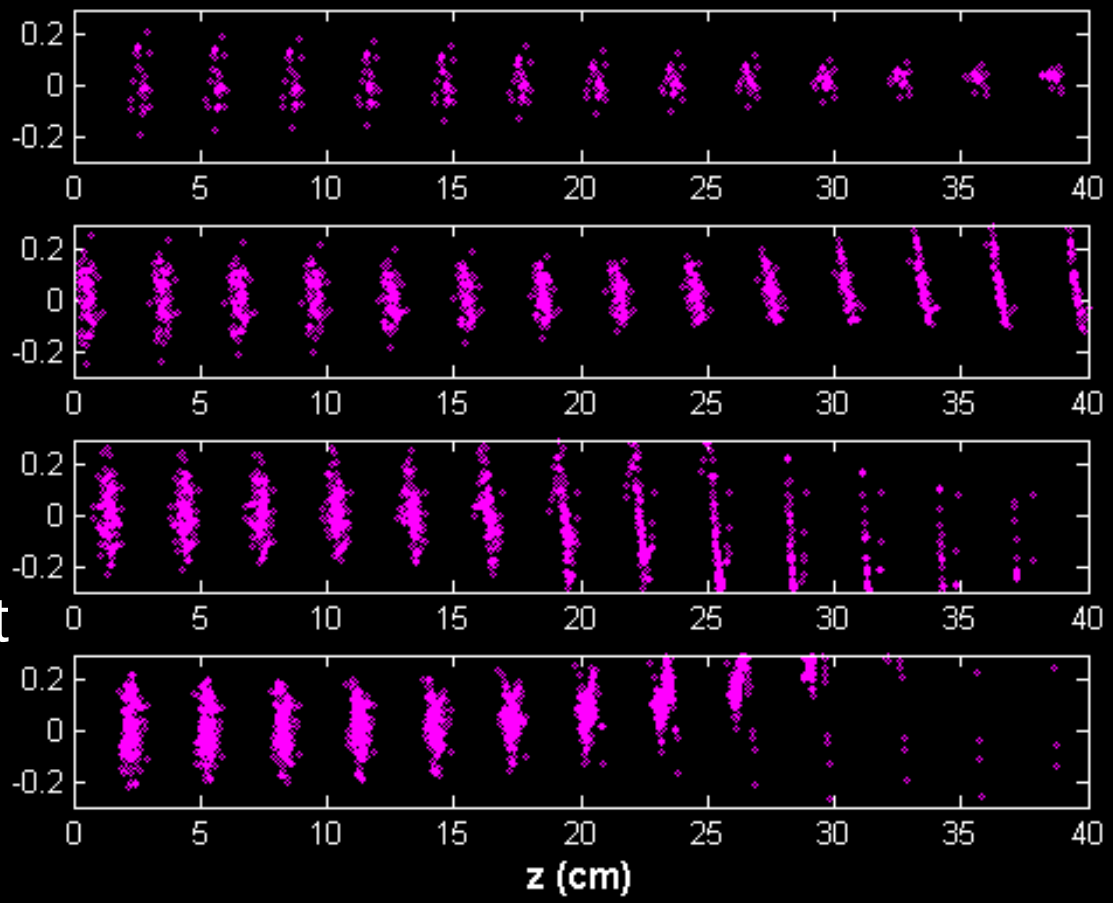
Ramped Bunch Train

- Develop transformer ratio R>2 by using train of bunches with linearly increasing intensities.
- Preliminary experiment performed at AWA with N_{bunch}=2. (Jing et al., PRL **98,** 144801 (2007))



- Simulation: No quad channel, initial 0.1 mm horizontal offset. Vertical extent of each plot is the diameter of the beam channel. Top to bottom, bunches 1-4, snapshots at 100 ps intervals. Severe losses without BBU control.

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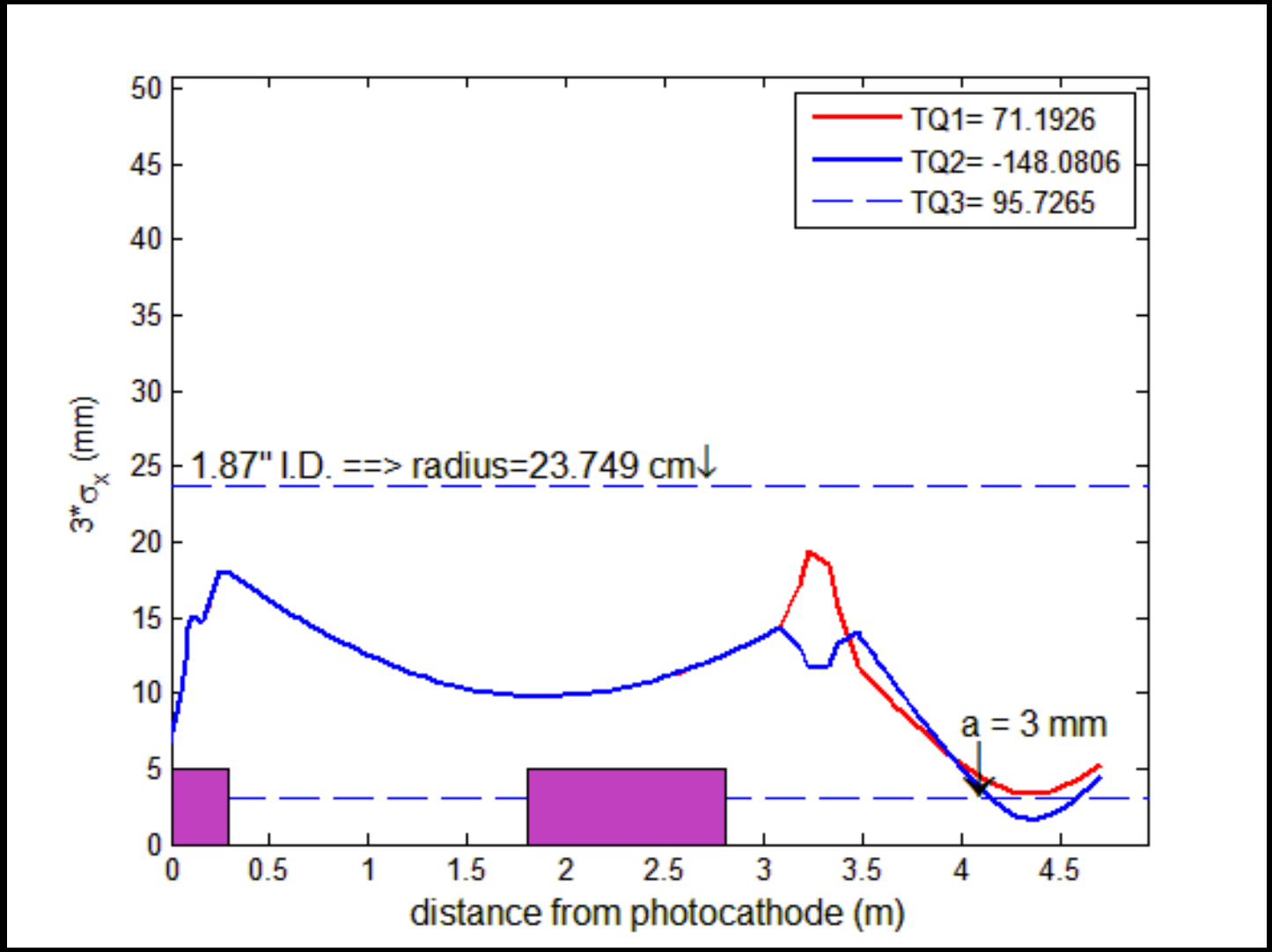
Beam optics: PARMELA Simulation

beam transport through the test section (JP)



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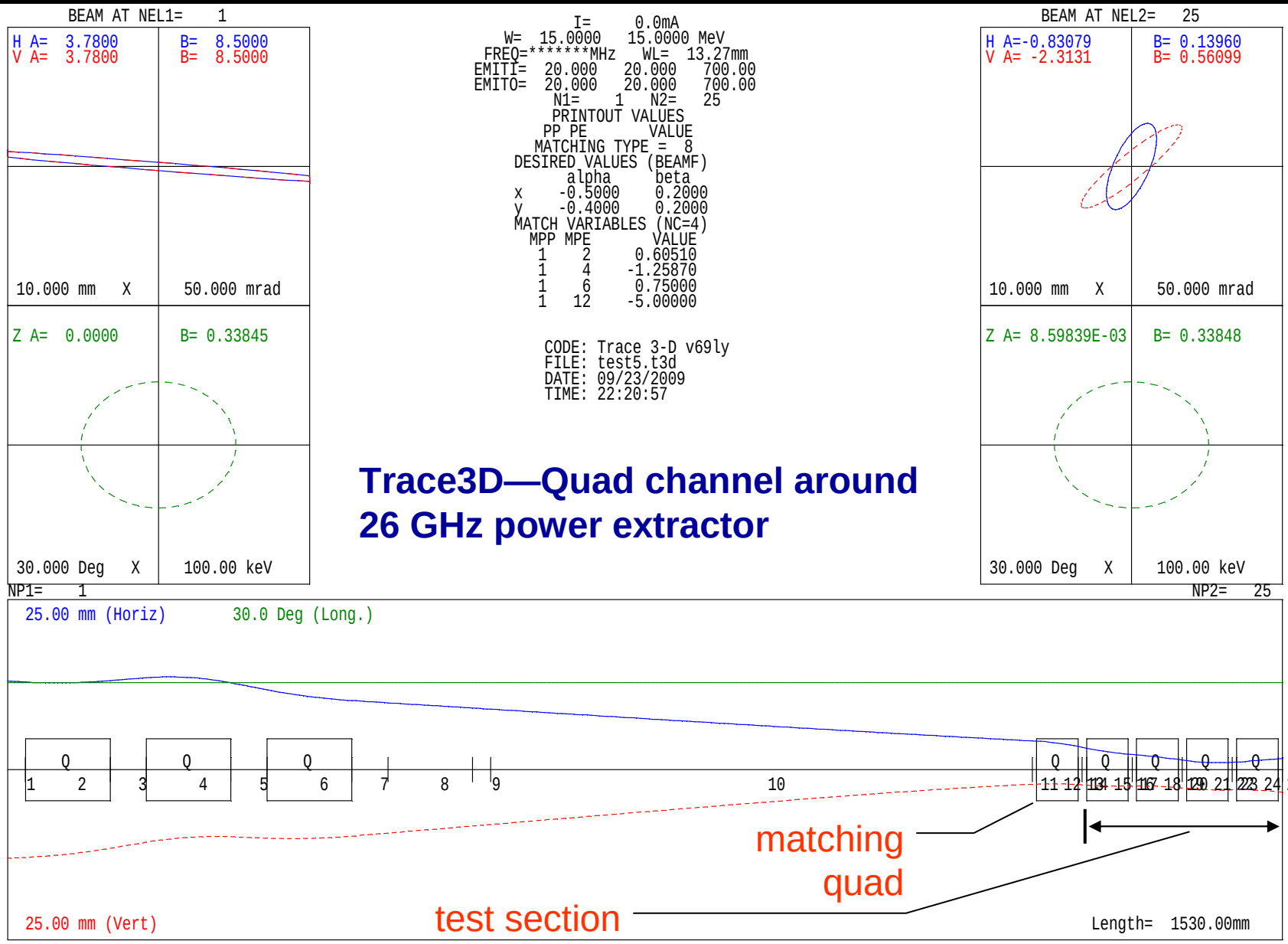
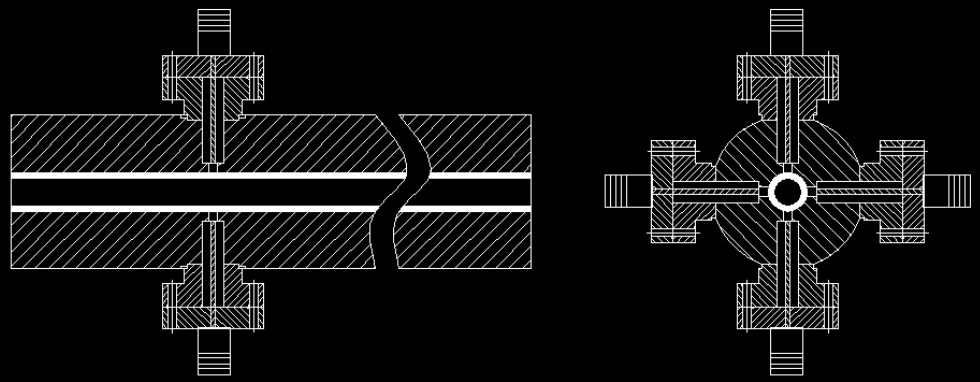


Trace3D—Quad channel around 26 GHz power extractor

Status

- Quad channel currently under design
- Power extractor will be the initial experiment on BBU control.
- New transverse stage for precise control of the beam offset.
- Wakefields measured using field probes mounted at 90^{o} in the structures. Four probes allow clean separation of accelerating and deflecting modes.



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